

User Guide for
FEBFLS1800XS1CH_L11U100A

100 W LED Driver at Universal Line

**Featured Fairchild Products:
FL7930B, FLS1800XS**

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This user guide supports the evaluation kit for the FL7930B and FLS1800XS (orderable as FEBFLS1800XS1CH_L11U100A). It should be used in conjunction with the FL7930B and FLS1800XS datasheets as well as Fairchild's application notes and technical support team. Please visit Fairchild's website at www.fairchildsemi.com.

1. Introduction

This document describes a proposed solution for an 100 W LED ballast, which consists of a boost converter for power factor correction (PFC), DC-DC converter with LLC resonant converter, and LED-current and voltage-regulation circuitry. The input voltage range is $90 V_{RMS} - 265 V_{RMS}$ and there is one DC output with a constant current of 1.0 A at $100 V_{MAX}$. The power supply mainly utilizes Fairchild semiconductor components: FL7930B CRM PFC controller, FLS1800XS half-bridge LLC controller with power MOSFET, LM2904 op-amp for LED current and voltage control, FDPF12N60NZ UniFET™ technology N-channel MOSFET, and FFPF08H60S “hyperfast” 2 rectifier. This document contains important information (e.g. schematic, bill of materials, printed circuit layout, and transformer design documentation) and the typical operating characteristics.

1.1. General Description of FL7390B

The FL7930B is an active Power Factor Correction (PFC) controller for low- and high-power lumens applications that operate in Critical Conduction Mode (CRM). It uses a voltage-mode PWM that compares an internal ramp signal with the error amplifier output to generate a MOSFET turn-off signal. Because the Voltage-Mode CRM PFC controller does not need rectified AC line voltage information, it saves the power loss of an input voltage-sensing network necessary for a Current-Mode CRM PFC controller. FL7930 provides over-voltage, open-feedback, over-current, input-voltage-absent detection, and under-voltage lockout protections. The FL7930B can be disabled if the INV pin voltage is lower than 0.45 V and the operating current decreases to a very low level. Using a new variable on-time control method, Total Harmonic Distortion (THD) is lower than the conventional CRM boost PFC ICs. The FL7930B provides an additional OVP pin that can be used to shutdown the boost power stage when output voltage exceeds OVP level due to damaged resistors connected at the INV pin.

1.2. Features

- Low Total Harmonic Distortion (THD)
- Precise Adjustable Output Over-Voltage Protection (OVP)
- Open-Feedback Protection and Disable Function
- Zero Current Detector (ZCD)
- 150 μ s Internal Startup Timer
- MOSFET Over-Current Protection (OCP)
- Under-Voltage Lockout with 3.5 V Hysteresis (UVLO)
- Low Startup (40 μ A) and Operating Current (1.5 mA)
- Totem-Pole Output with High-State Clamp
- +500 / -800 mA Peak Gate Drive Current
- SOP-8 Packaging

1.3. Internal Block Diagram

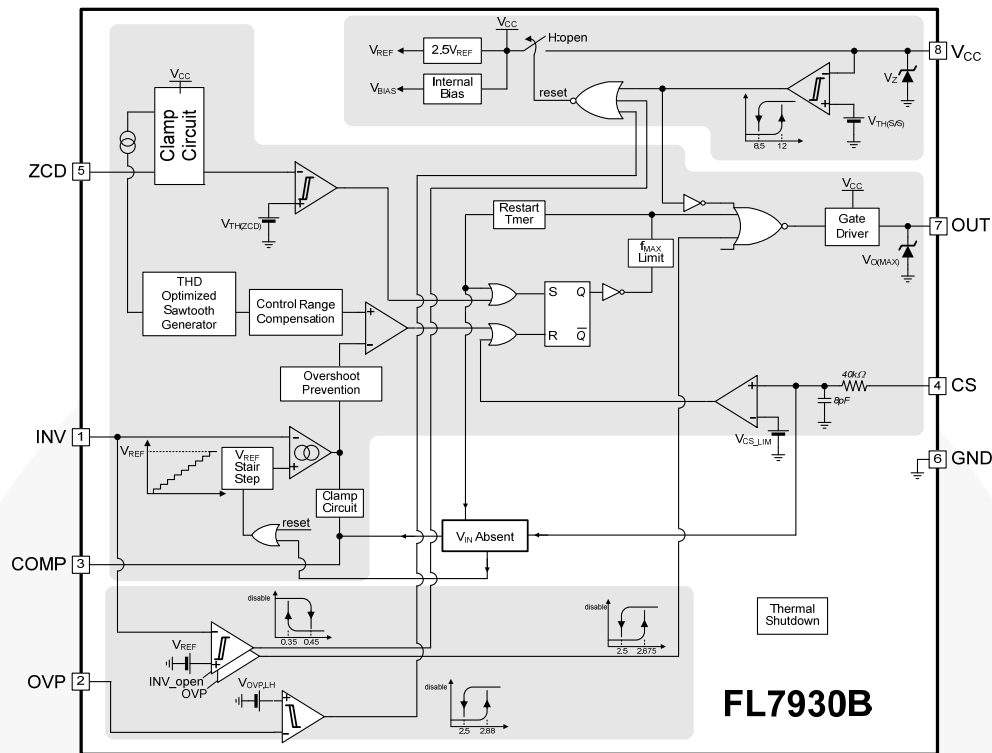


Figure 1. Block Diagram of FL7930B

1.4. General Description of FLS1800XS

The FLS1800XS power controller includes highly integrated power switches for medium- to high-power lumens applications. Offering everything necessary to build a reliable and robust half-bridge resonant converter, the FLS1800XS simplifies designs, improves productivity, and improves performance. The FLS1800XS series combines power MOSFETs with fast-recovery type body diodes, a high-side gate-drive circuit, an accurate current-controlled oscillator, frequency-limit circuit, soft-start, and built-in protection functions. The high-side gate-drive circuit has common-mode noise-cancellation capability, which guarantees stable operation with excellent noise immunity. The fast-recovery body diode of the MOSFETs improves reliability against abnormal operation conditions, while minimizing the effects of reverse recovery. Using Zero-Voltage Switching (ZVS) dramatically reduces the switching losses and significantly improves efficiency. ZVS also reduces switching noise noticeably, which enables use of a small-sized Electromagnetic Interference (EMI) filter. The FLS1800XS can be applied to resonant converter topologies such as series resonant, parallel resonant, and LLC resonant converters.

1.5. Features

- Variable Frequency Control with 50% Duty Cycle for Half-Bridge Resonant Converter Topology
- High Efficiency through Zero-Voltage Switching (ZVS)
- Internal UniFET™ (0.95 Ω) with Fast-Recovery Body Diode
- Fixed Dead Time (350 ns) Optimized for MOSFETs
- Up to 300 kHz Operating Frequency
- Auto-Restart Operation for All Protections with External LVCC
- Protections: Over-Voltage Protection (OVP), Over-Current Protection (OCP), Abnormal Over-Current Protection (AOCP), Internal Thermal Shutdown (TSD)

1.6. Internal Block Diagram

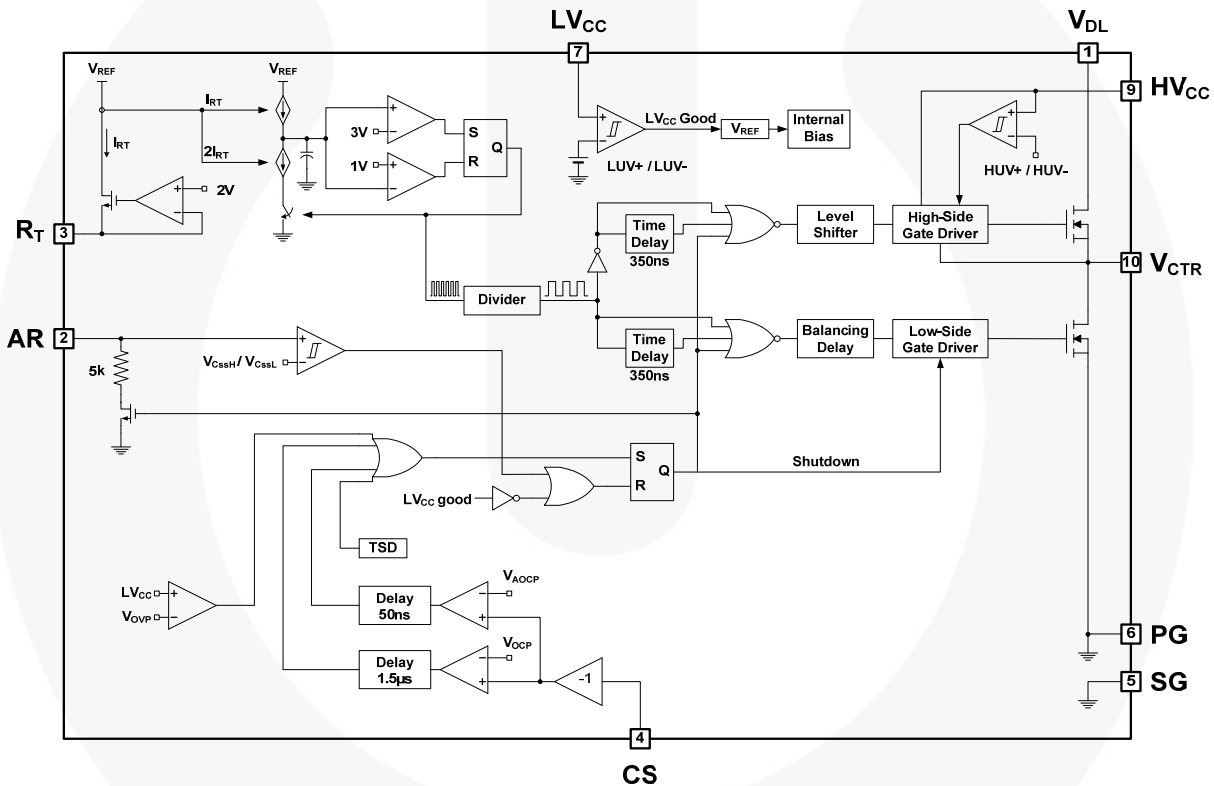


Figure 2. Block Diagram of FLS1800XS

2. Specifications for Evaluation Board

Table 1. Specifications for LED Lighting Lamp

Description		Symbol	Value	Comments
Input	Voltage	V _{IN.MIN}	90 V	Minimum Input Voltage
		V _{IN.MAX}	265 V	Maximum Input Voltage
		V _{IN.NOMINAL}	110 V / 220 V	Nominal Input Voltage
	Frequency	f _{IN}	60 Hz / 50 Hz	Line Frequency
Output	Voltage	V _{OUT}	100 V	Nominal Output Voltage
	Current	I _{OUT}	1 A	Nominal Output Current
		CC Deviation	< 0.79%	Line & Load Regulation
Efficiency		Eff _{85VAC}	91.73%	Efficiency at 85 V _{AC} Line Input Voltage
		Eff _{115VAC}	92.55%	Efficiency at 115 V _{AC} Line Input Voltage
		Eff _{235VAC}	95.01%	Efficiency at 235 V _{AC} Line Input Voltage
		Eff _{265VAC}	95.11%	Efficiency at 265 V _{AC} Line Input Voltage
PF / THD		PF/THD _{85VAC}	0.986 / 12.56%	PF/THD at 85 V _{AC} Line Input Voltage
		PF/THD _{115VAC}	0.989 / 12.01%	PF/THD at 115 V _{AC} Line Input Voltage
		PF/THD _{235VAC}	0.930 / 9.8%	PF/THD at 235 V _{AC} Line Input Voltage
		PF/THD _{265VAC}	0.891 / 15.47%	PF/THD at 265 V _{AC} Line Input Voltage

All data of the evaluation board was measured with the board enclosed in a case and external temperature of around 25°C.

3. Photographs

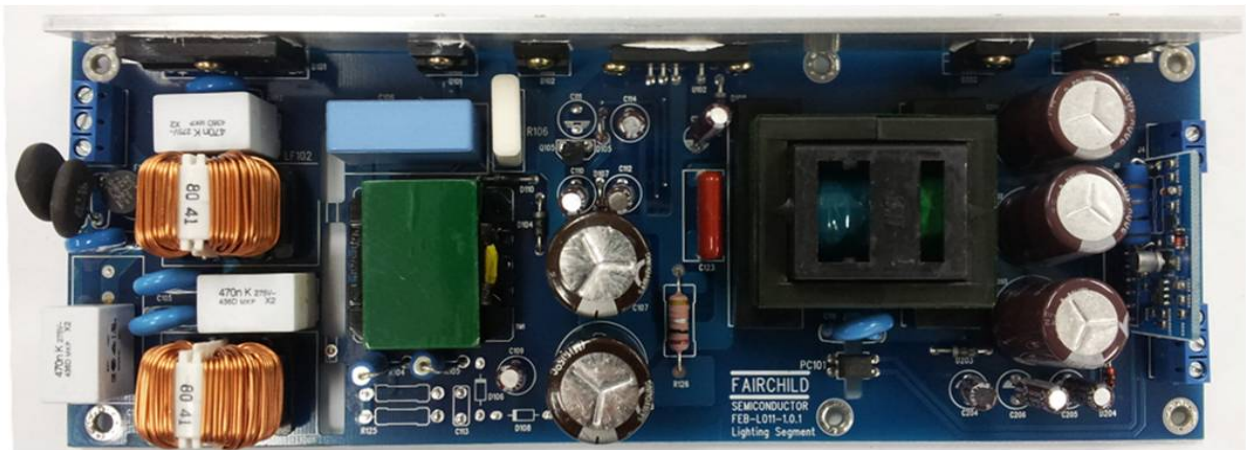


Figure 3. Top View (Dimensions: 225 mm (L) x 80 mm (W) x 30 mm (H))

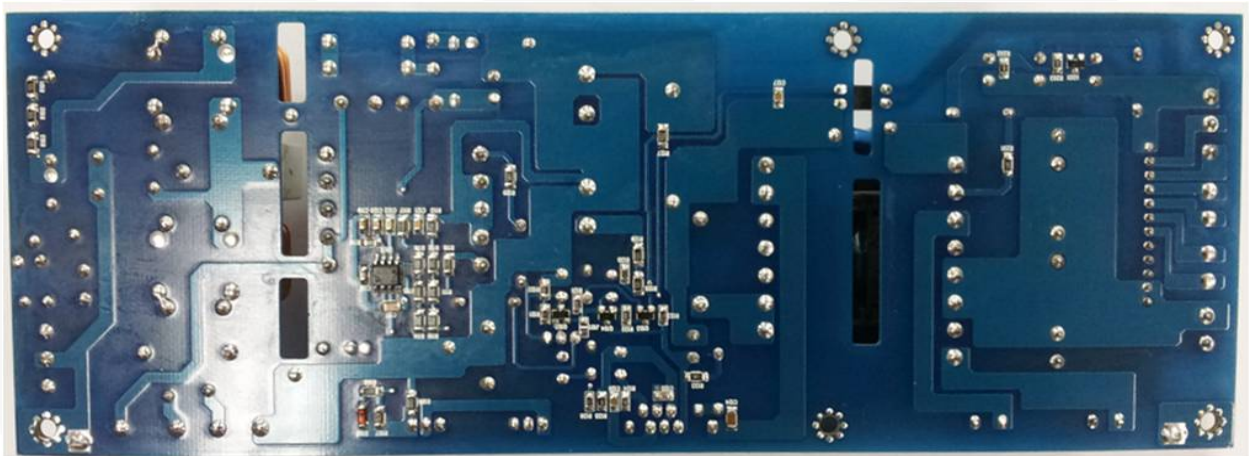


Figure 4. Bottom Views (Dimensions: 225 mm (L) x 80 mm (W) x 30 mm (H))

4. Printed Circuit Board

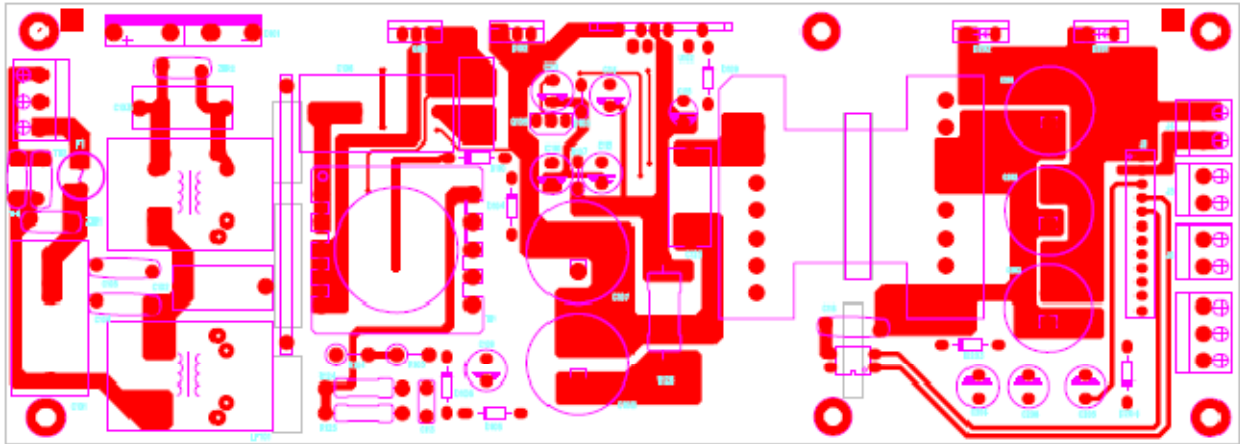


Figure 5. Top Pattern

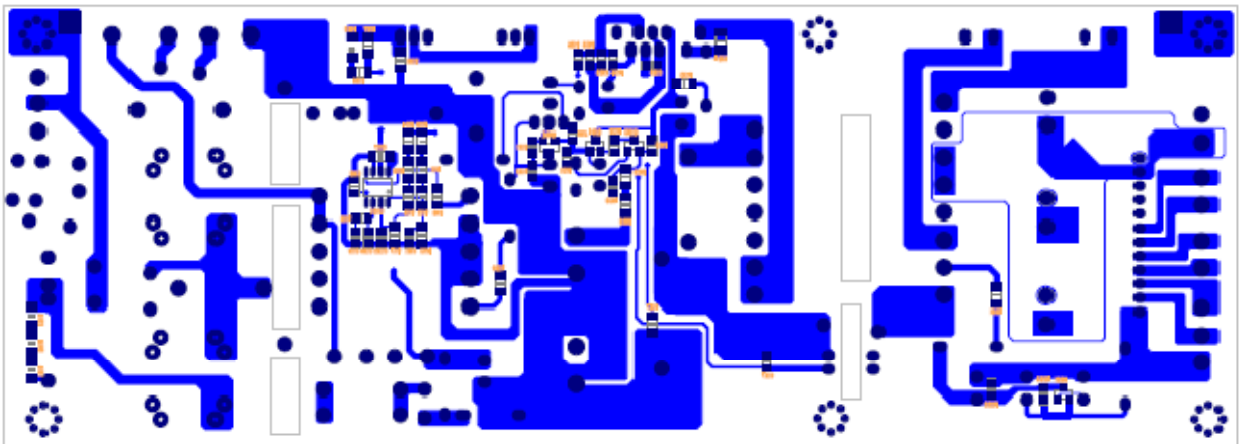


Figure 6. Bottom Pattern

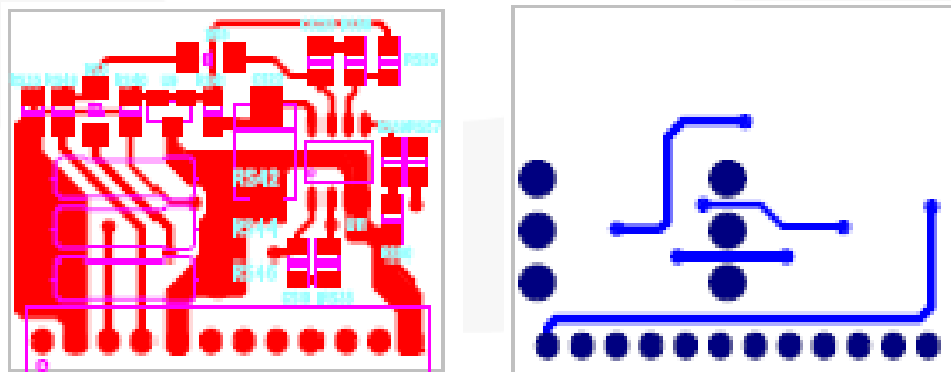


Figure 7. Top / Bottom Sub Board (CC / CV Control Part) Pattern

5. Schematic

5.1. Power Factor Correction (PFC)

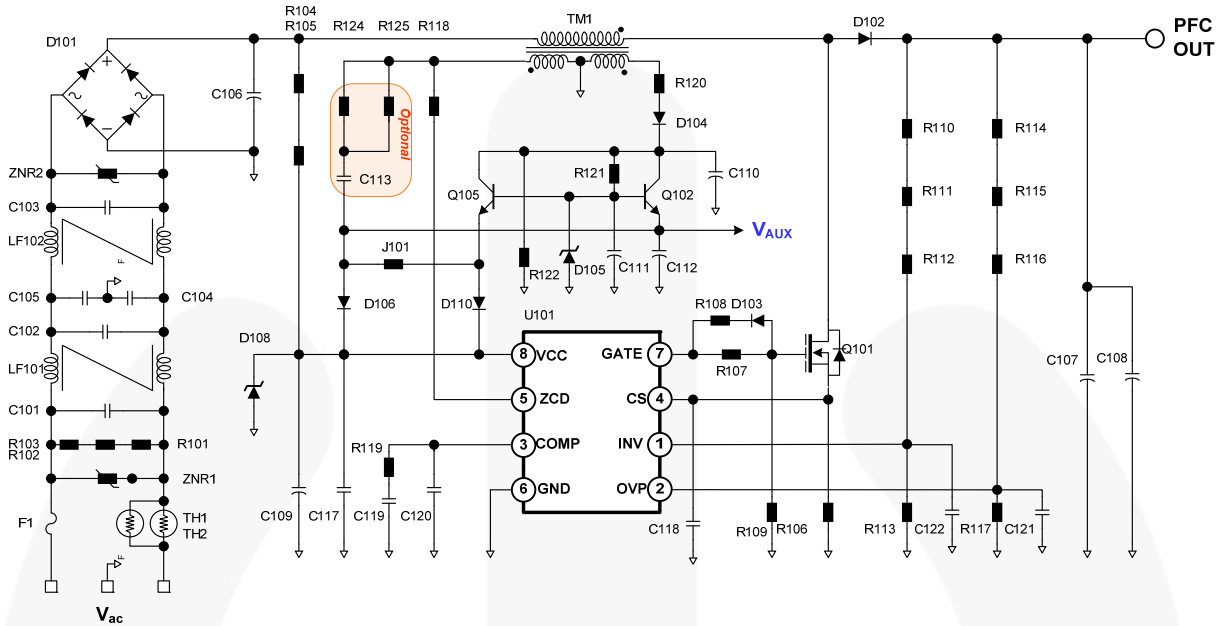


Figure 8. Schematic for PFC

5.2. DC-to-DC Converter and CC / CV Control

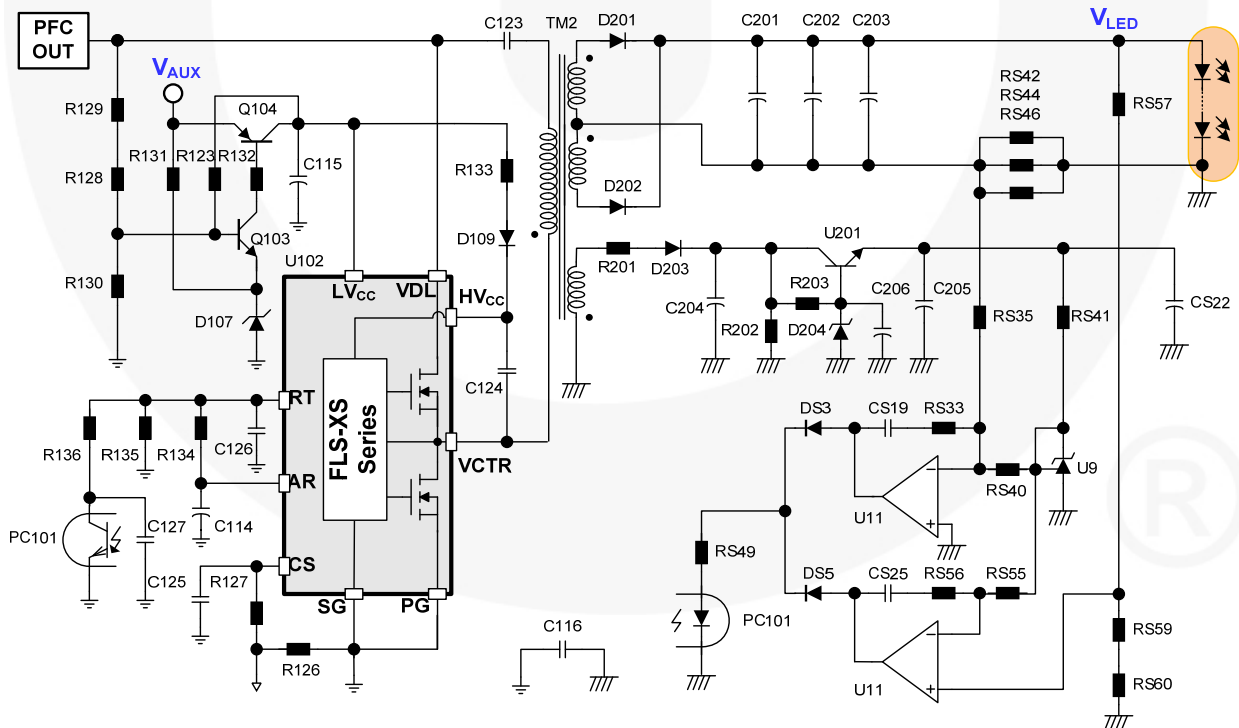


Figure 9. Schematic for DC-to-DC Converter and CC / CV Control

6. Bill of Materials

6.1. Main Board (PFC and DC-to-DC Converter)

Item No.	Part Reference	Value	Qty.	Description
1	U101	FL7930B	1	8-SOP, Fairchild Semiconductor
2	U102	FLS1800XS	1	9-SIP, Fairchild Semiconductor
3	PC101	PC817	1	Opto-Coupler, Fairchild Semiconductor
4	C101, C102, C103	0.47 μ F	3	X - Capacitor
5	C104, C105	4700 pF	2	Y - Capacitor
6	C106	0.68 μ F / 630 V _{AC}	1	Film Capacitor
7	C107, C108	120 μ F / 450 V	2	Electrolytic Capacitor
8	C109	22 μ F / 50 V	1	Electrolytic Capacitor
9	C110, C112 C204, C205, C206	33 μ F / 50 V	5	Electrolytic Capacitor
10	C111, C113	NC		No Connection
11	C114	10 μ F / 16 V	1	Electrolytic Capacitor
12	C115	0.33 μ F / 25 V	1	Electrolytic Capacitor
13	C116	3.3 nF	1	AC Ceramic Capacitor
14	C117	0.1 μ F / 50 V	1	Chip Capacitor
15	C118	470 pF	1	Chip Capacitor
16	C119, C124	0.22 μ F	2	Chip Capacitor
17	C120	47 nF	1	Chip Capacitor
18	C121, C122	1 nF	2	Chip Capacitor
19	C123	15 nF / 630 V	1	Film Capacitor
20	C125	100 pF	1	Chip Capacitor
21	C126	680 pF	1	Chip Capacitor
22	C127	12 nF	1	Chip Capacitor
23	C201, C202, C203	100 μ F / 200 V	3	Electrolytic Capacitor
24	D101	D15XB60	1	Shindengen/Bridge Diode
25	D102, D201, D202	FFPF08H60S	3	Fairchild Semiconductor
26	D103	1N4148	1	LL-34, Fairchild Semiconductor
27	D104, D109, D110, D203	UF4007	4	Fairchild Semiconductor
28	D105, D204	1N4745	2	Fairchild Semiconductor
29	D107	1N4736	1	Fairchild Semiconductor
30	D106, D108	NC		No Connection
31	Q101	FDPF12N60NZ	1	Fairchild Semiconductor
33	Q102, Q103, U201	Q2N2222A	3	SOT-23, Fairchild Semiconductor
34	Q105	2N2222A	1	TO-92, Fairchild Semiconductor
35	Q104	2N2907	1	SOT-23, Fairchild Semiconductor
36	R101, R102, R103, R128, R129	1 M Ω -J	5	SMD Resistor, 3216
37	R104, R105	69 k Ω	2	2 W

6.1. Main Board (PFC and DC-to-DC Converter)

Item No.	Part Reference	Value	Qty.	Description
38	R106	0.1 Ω	1	5 W
39	R107	47 Ω -J	1	SMD Resistor, 3216
40	R108	4.7 Ω -J	1	SMD Resistor, 3216
41	R109, R119, R131, R132, R203	10 k Ω -J	5	SMD Resistor, 3216
42	R110, R111, R112, R114, R115, R116	3.9 M Ω -J	6	SMD Resistor, 3216
43	R113	75 k Ω -J	1	SMD Resistor, 3216
44	R117	68 k Ω -J	1	SMD Resistor, 3216
45	R118	24 k Ω -J	1	SMD Resistor, 3216
46	R120, R133, R201	5.1 Ω -J	3	SMD Resistor, 3216
47	R121	33 k Ω -J	1	SMD Resistor, 2012
48	R122, R202	100 k Ω -J	2	SMD Resistor, 2012
49	R123	390 k Ω -J	1	SMD Resistor, 2012
50	R124, R125	NC		Optional
51	R126	0.1 Ω	1	1 W
52	R127	1 k Ω -J	1	SMD Resistor, 2012
53	R130	47 k Ω -J	1	SMD Resistor, 2012
54	R134	2.7 Ω -J	1	SMD Resistor, 2012
55	R135	5.6 k Ω -J	1	SMD Resistor, 2012
56	R136	2 k Ω -J	1	SMD Resistor, 2012
57	TH1, TH2	5D15	2	NTC
58	ZNR1, ZNR2	10D471	2	Varistor
59	TM1	280 μ H	1	EER3019N-10
60	TM2	L _p = 850 μ H L _R = 170 μ H	1	EER3543-16
61	LF101, LF102	40 mH	2	Line Filter
62	F1	250 V / 5 A	1	Fuse
63	J101	NC		Optional

6.2. Sub Board for CC / CV Control

Item No.	Part Reference	Value	Qty.	Description
1	U9	KA431SLMF	1	SOT-23, Fairchild Semiconductor
2	U11	LM2904	1	8-SOP
3	RS33	47 kΩ-J	1	SMD Resistor, 3216
4	RS35	13 kΩ-J	1	SMD Resistor, 3216
5	RS40	100 kΩ-J	1	SMD Resistor, 3216
6	RS41	4.7 kΩ-J	1	SMD Resistor, 3216
7	RS49	1 kΩ-J	1	SMD Resistor, 3216
8	RS55	120 kΩ-J	1	SMD Resistor, 3216
9	RS56	47 kΩ-J	1	SMD Resistor, 3216
10	RS57	330 kΩ-J	1	SMD Resistor, 3216
11	RS59	8.2 kΩ-J	1	SMD Resistor, 3216
12	RS60	3 Ω-J	1	SMD Resistor, 2012
13	CS19	220 nF	1	Chip Capacitor
14	CS25	220 nF	1	Chip Capacitor
15	CS22	10 μF / 25 V	1	Electrolytic Capacitor
16	DS3, DS5	1N4148	2	LL-34, Fairchild Semiconductor
17	RS42	NC		No Connection
18	RS44	0.1 Ω	1	2 W
19	RS46	NC		No Connection

7. Transformer Design

7.1. PFC Transformer (TM1)

- Core: EER3019N (SAMHWA PL-7)
- Bobbin: 10 pin

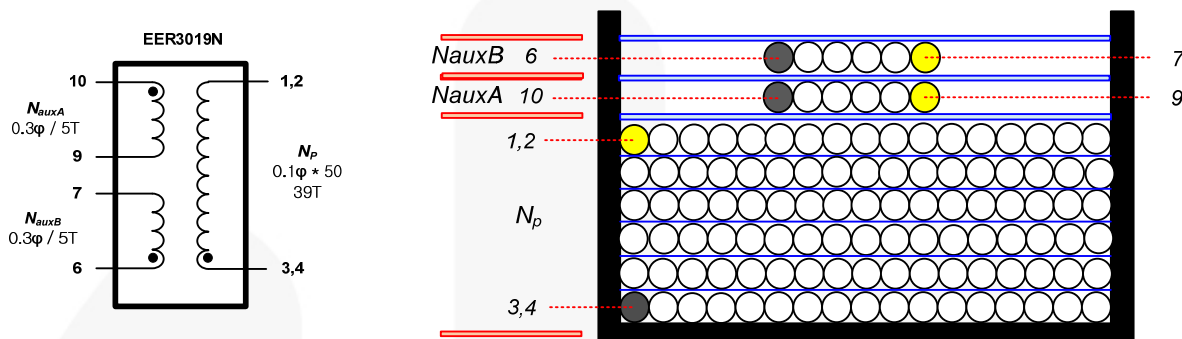


Figure 10. Transformer Specifications & Construction

Table 2. Winding Specifications

No.	Winding	Pin (S → F)	Wire	Turns	Winding Method
1	Np	3, 4 → 1, 2	0.1φ × 50	39 Ts	Solenoid Winding
2	Insulation: Polyester Tape t = 0.025 mm, 3-Layer				
3	NauxA	10 → 9	0.3φ	5 Ts	Solenoid Winding
4	Insulation: Polyester Tape t = 0.025 mm, 3-Layer				
5	NauxB	6 → 7	0.3φ	5 Ts	Solenoid Winding
6	Insulation: Polyester Tape t = 0.025 mm, 3-Layer				

Table 3. Electrical Characteristics

	Pin	Specifications	Remark
Inductance	3, 4 – 1, 2	280 μH ±5%	100 kHz, 1 V

7.2. LLC Resonant Converter Transformer (TM2)

- Core: EER3543
- Bobbin: 16 pin

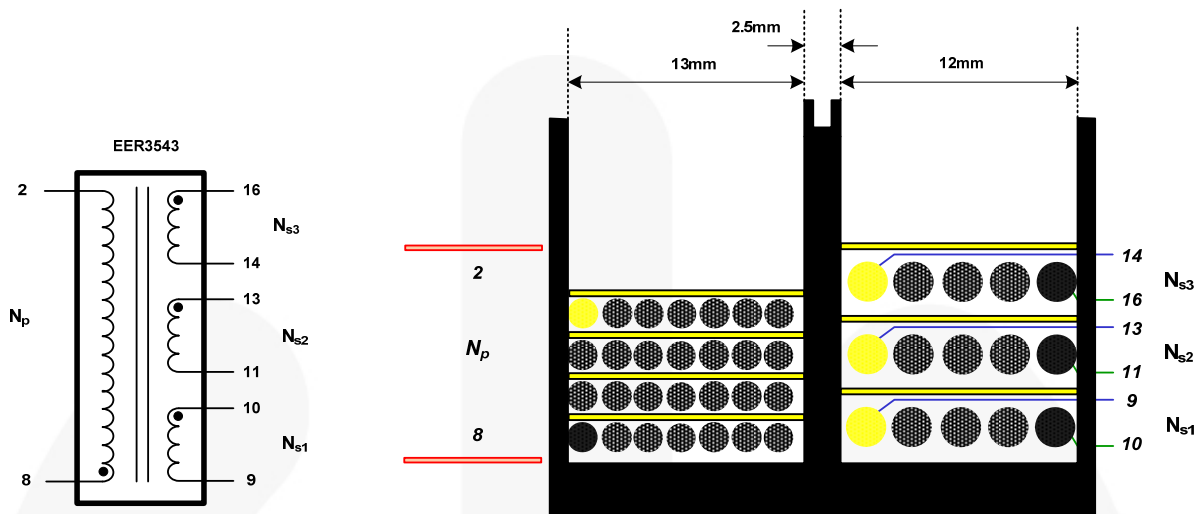


Figure 11. Transformer Specifications & Construction

Table 4. Winding Specifications

No	Winding	Pin (S → F)	Wire	Turns	Winding Method
1	Np	8 → 2	0.1φ × 20	38 Ts	Solenoid Winding
2	Insulation: Polyester Tape t = 0.025 mm, 3-Layer				
3	Ns1	10 → 9	0.3φ	2 Ts	Solenoid Winding
4	Insulation: Polyester Tape t = 0.025 mm, 3-Layer				
5	Ns2	13 → 11	0.1φ×20	17 Ts	Solenoid Winding
6	Insulation: Polyester Tape t = 0.025 mm, 3-Layer				
7	Ns3	16 → 14	0.1φ×10	17Ts	Center Solenoid Winding
8	Insulation: Polyester Tape t = 0.025 mm, 3-Layer				

Table 5. Electrical Characteristics

	Pin	Specification	Remark
Primary-Side Inductance (L_p)	2 – 8	850 μ H $\pm$ 5%	100 KHz, 1 V
Primary-Side Effective Leakage (L_R)	2 – 8	Maximum 170 μ H	Short One of the Secondary Windings

8. Performance of Evaluation Board

Table 6. Test Condition & Equipments

Ambient Temperature	$T_A = 25^\circ\text{C}$
Test Equipment	AC Source: ES2000S by NF Electronic Load: EML-05B by Fujitsu Power Meter: PM6000 by Voltech Oscilloscope: Wave-runner 104Xi by LeCroy

8.1. Overall System Efficiency

Figure 12 shows at least 91% overall system efficiency is achievable with universal input condition at the rated output LED load.

Efficiency [%]

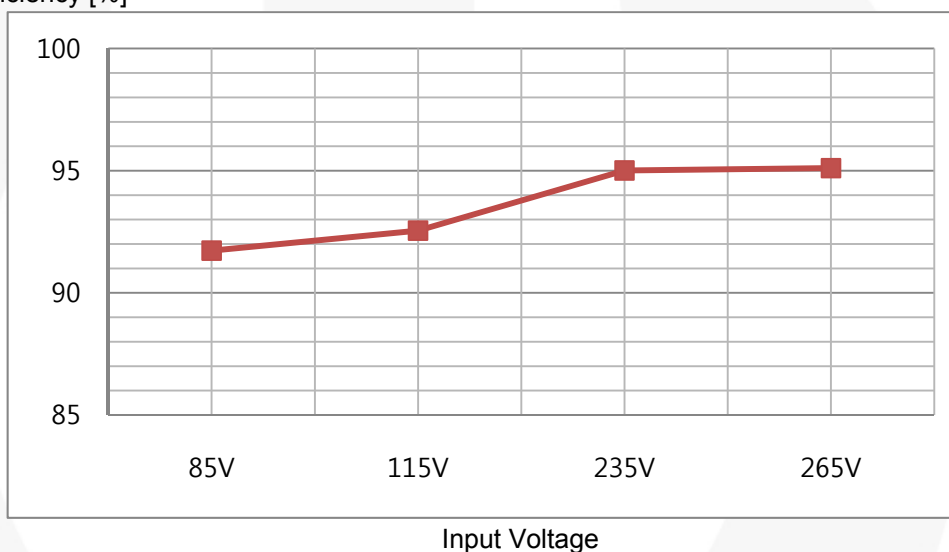


Figure 12. System Efficiency Curve

Table 7. System Efficiency

Input Voltage	85 V _{AC}	115 V _{AC}	235 V _{AC}	265 V _{AC}
Input Power [W]	112.04	111.18	108.46	108.47
Output Power [W]	102.77	102.89	103.05	103.16
Efficiency [%]	91.73	92.55	95.01	95.11

8.2. Power Factor (PF)

Figure 13 shows at least 89% power factor (PF) is achievable with universal input condition at the rated output LED load.

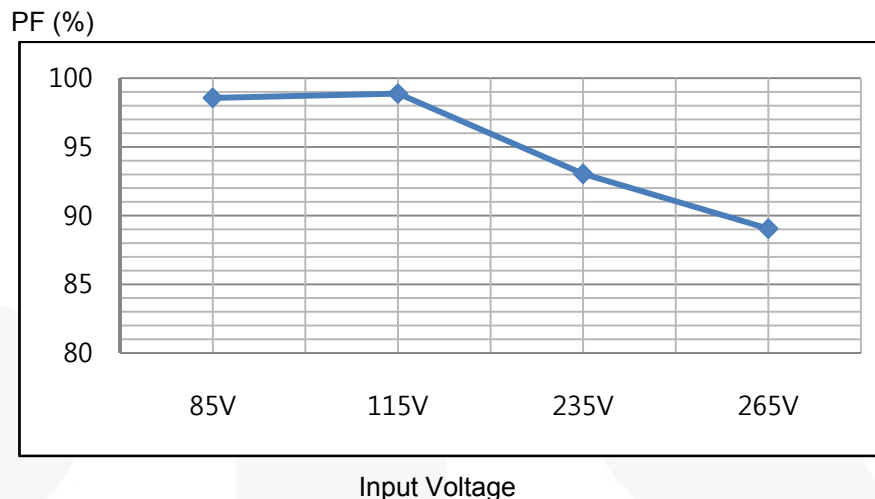


Figure 13. Power Factor Curve

Table 8. Power Factor

Input Voltage	85 V _{AC}	115 V _{AC}	235V _{AC}	265 V _{AC}
Power Factor [%]	98.57	98.88	93.04	89.05
THD [%]	12.56	12.01	9.80	15.47

Figure 14 shows the current harmonic result at the rated output power 100 W and input voltage 230 V_{AC} and 50 Hz condition based on IEC61000-3 class-C for lighting application. This meets international regulations.

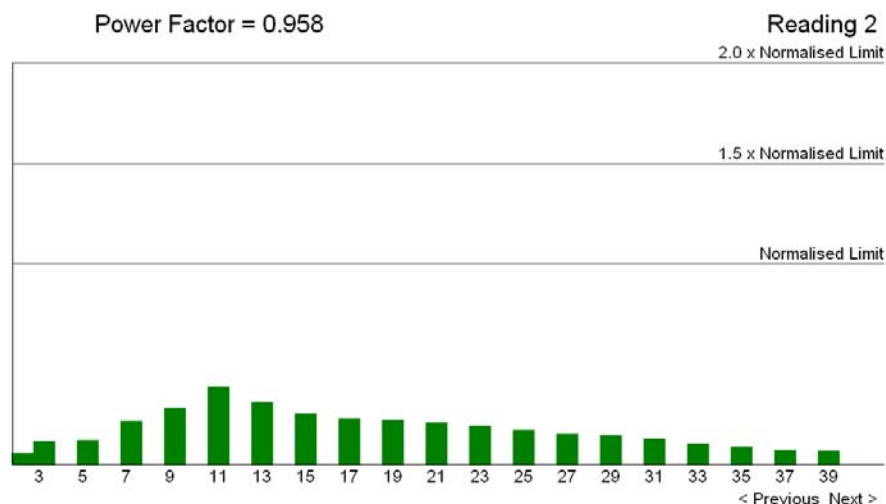


Figure 14. Total Harmonic Distortion (THD)

8.3. Constant Voltage and Current Regulation

Figure 15, Table 9, and Table 10 show the typical CC / CV performance on the board, displaying very stable CC performance over a wide input range.

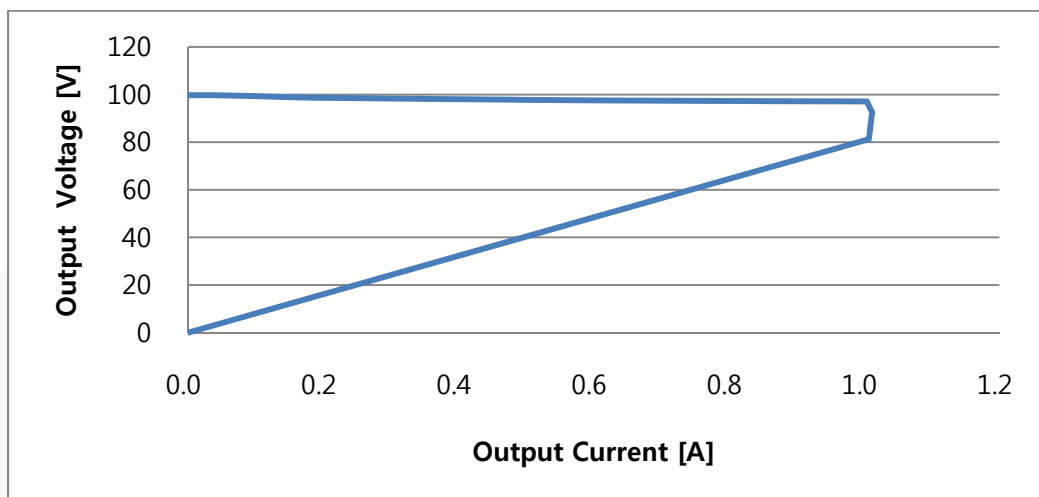


Figure 15. Constant Voltage and Current Regulation, Measured by E-Load [CR Mode]

Table 9. Output Voltage Regulation Performance

Output Voltage [V]	99.300	98.678	98.348	98.135	97.819	97.604	97.460
Output Current [mA]	100	201	300	400	500	600	700
Output Voltage [V]	97.346	97.220	97.132	92.469	88.555	83.579	81.279
Output Current [mA]	798	903	1004	1012.5	1009.9	1008.1	1006.8

Table 10. Output Voltage, Current Regulation Performance in CV / CC Region

CC / CV	Mode	CV Mode	CC Mode
	Maximum Output	99.30 V	1.01 A
	Minimum Output	97.23 V	1.00 A
	Difference	2.07 V	0.01 A
	Average	98.72 V	1.01 A
	Deviation	2.10%	0.79%

8.4. Overall Startup Performance

Figure 16 and Figure 17 show the startup performance including boost converter, LLC resonant converter, and CV / CC circuitry. The output load current starts flowing after about 357 ms and 139 ms for input voltage of 90 V_{AC} and 265 V_{AC} when the AC input power switch is turned on; CH1: V_{CC_PFC} (10 V / div), CH2: V_{CC_LLC} (10 V / div), CH3: V_{CC_CC/CV} (10 V / div), CH4: I_{LOAD} (1A / div), time scale: 100 ms / div.

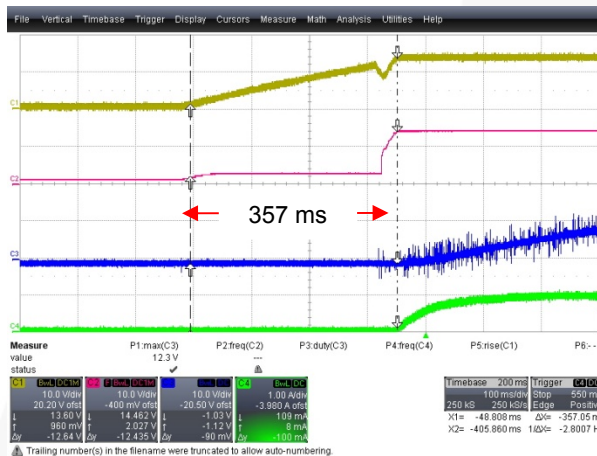


Figure 16. V_{IN} = 95 V_{AC}

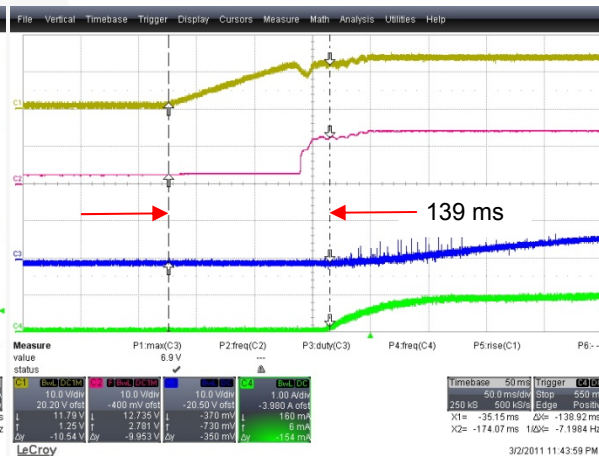


Figure 17. V_{IN} = 265 V_{AC}

8.5. Startup Performance of PFC

Figure 18 and Figure 19 show the typical startup performance on the PFC converter. It is possible to have a long startup time at 95 V_{AC} condition rather than 265 V_{AC} condition. This time depends on starting resistor and capacitor on board; CH1: V_{CC_PFC} (5 V / div), CH2: V_{PFC} (100 V / div), time scale: 100 ms / div.

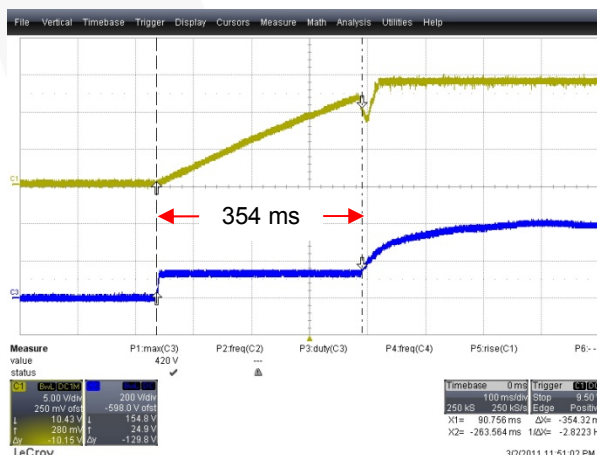


Figure 18. V_{IN} = 95 V_{AC}

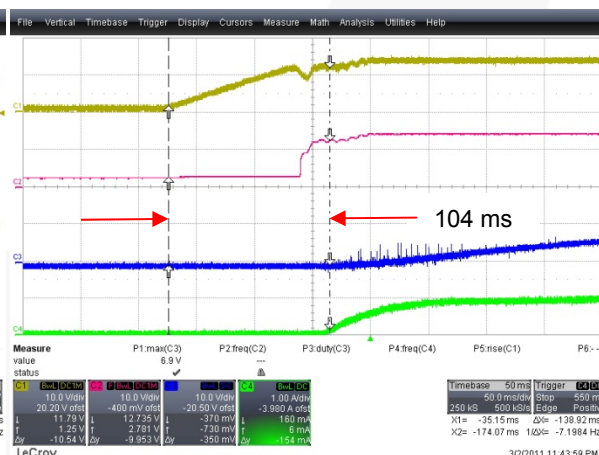


Figure 19. V_{IN} = 265 V_{AC}

8.6. Soft-Start Performance of PFC

Figure 20 through Figure 23 show the soft-start performance at output power of 100 W. Measured PFC output voltage reaches from 398V to 401 V at input voltage of 95 V_{AC} and 265 V_{AC}; CH1: V_{CC_PFC} (10 V / div), CH3: V_{PFC} (20 V / div), time scale: 200 ms / div.

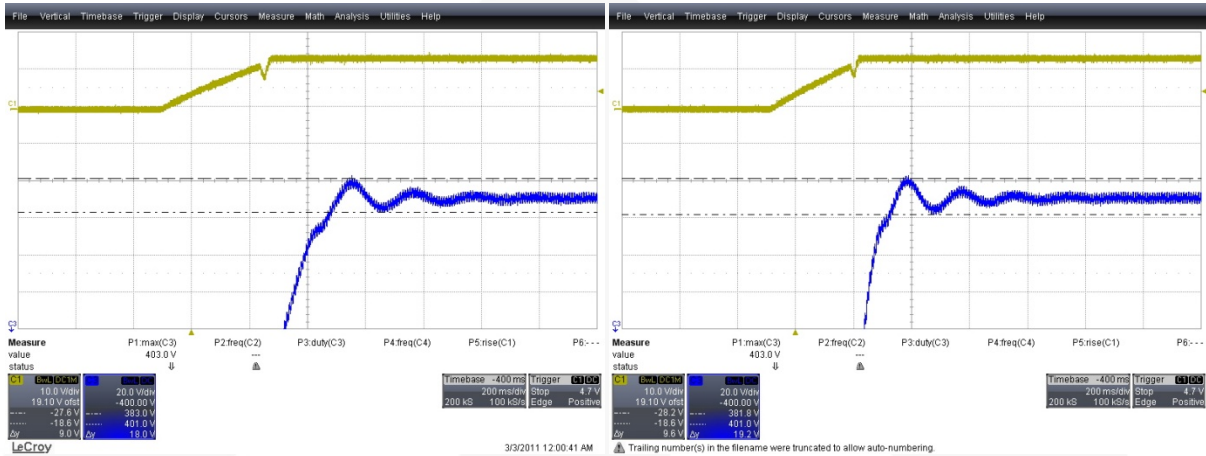


Figure 20. V_{IN} = 95 V_{AC}

Figure 21. V_{IN} = 115 V_{AC}

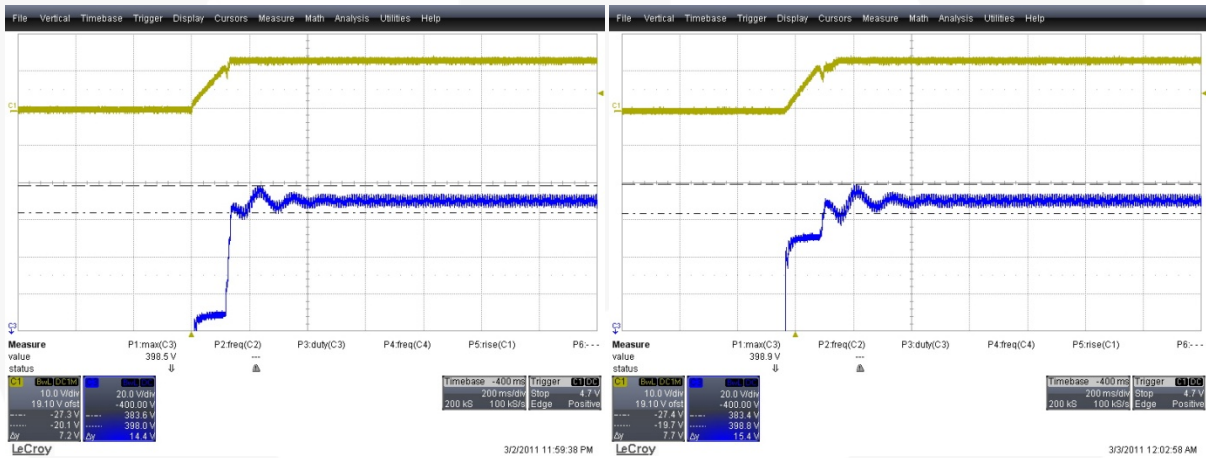


Figure 22. V_{IN} = 235 V_{AC}

Figure 23. V_{IN} = 265 V_{AC}

8.7. Power On / Off Performance of DC-to-DC Converter

Figure 24 and Figure 25 show the soft-start waveforms at full-load and light-load conditions, respectively, for the nominal input voltage condition; CH2: V_{PFC} (50 V / div), CH4: I_{LLC} (2 A / div), time scale: 50 ms / div.

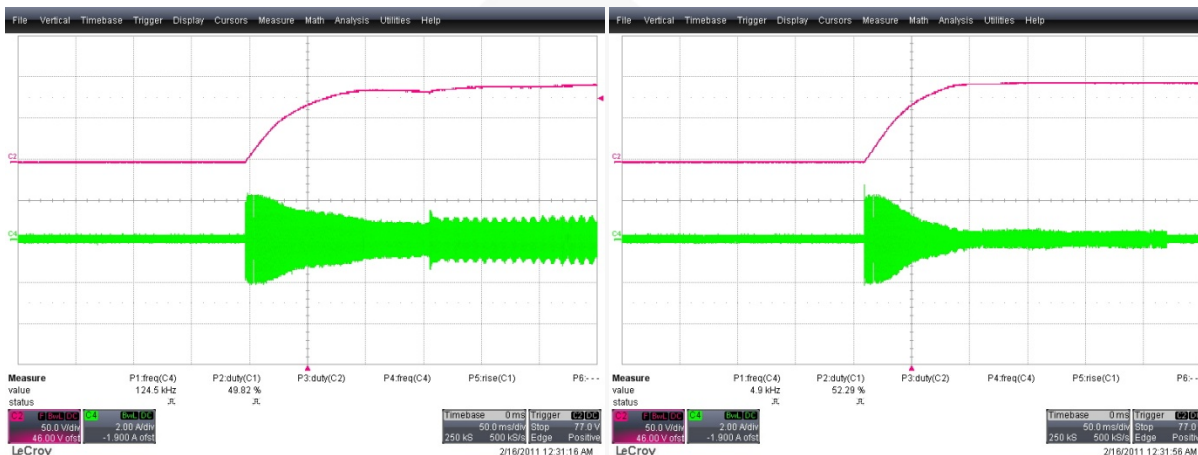


Figure 24. $V_{PFC} = 400$ V, $P_O = 100$ W

Figure 25. $V_{PFC} = 400$ V, $P_O = 10$ W

Figure 26 shows the startup waveforms when the input voltage source is supplied first, then the V_{CC} of 16 V is applied from the auxiliary winding of the PFC transformer.

Figure 27 shows the shutdown waveforms when the input voltage source is turned off. When the DC bus voltage reaches about 260 V, the external brownout circuit disconnects V_{CC} from FLS1800XS, so it stops operation; CH1: V_{CC_LLC} (10 V / div), CH2: V_{PFC} (200 V / div), CH4: I_{LLC} (2 A / div).

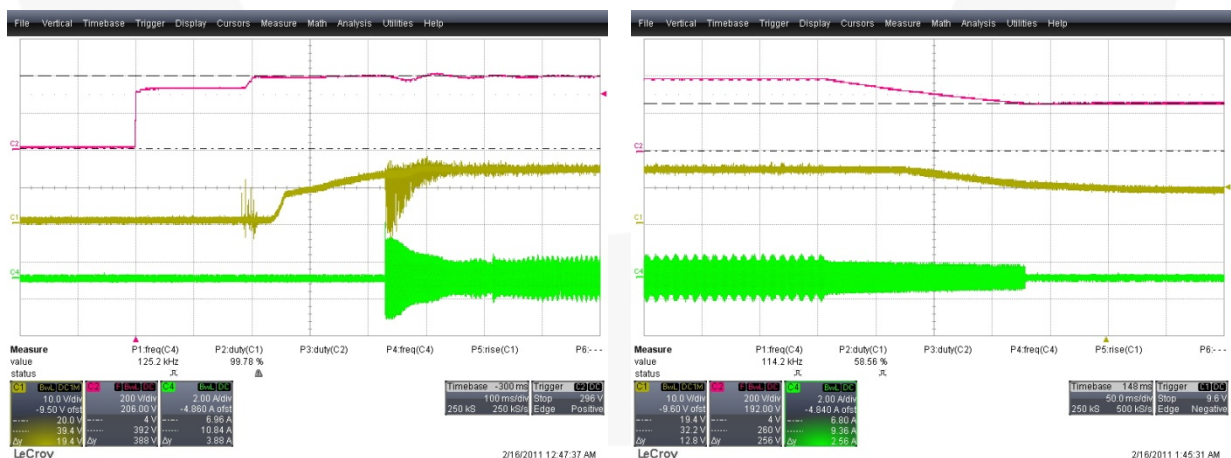
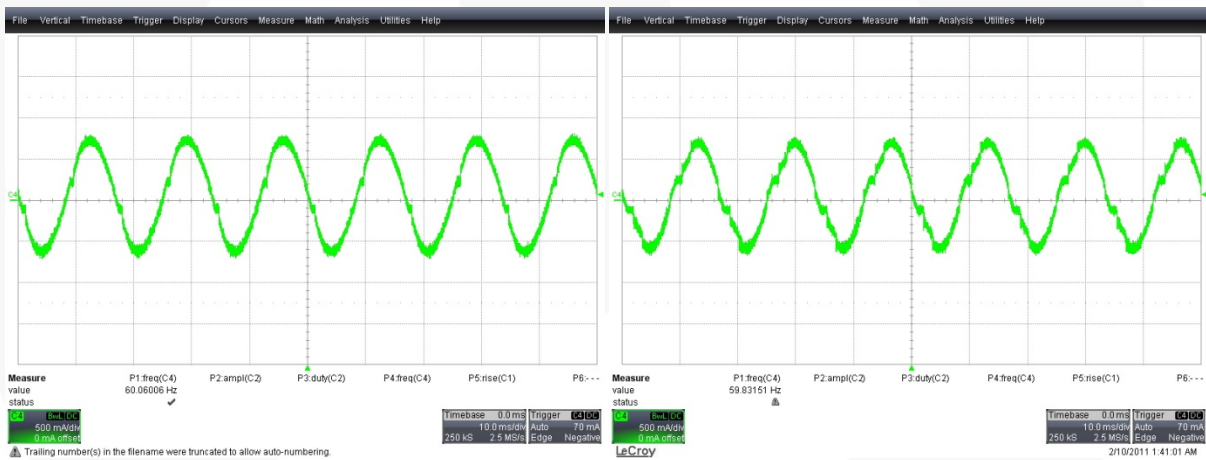
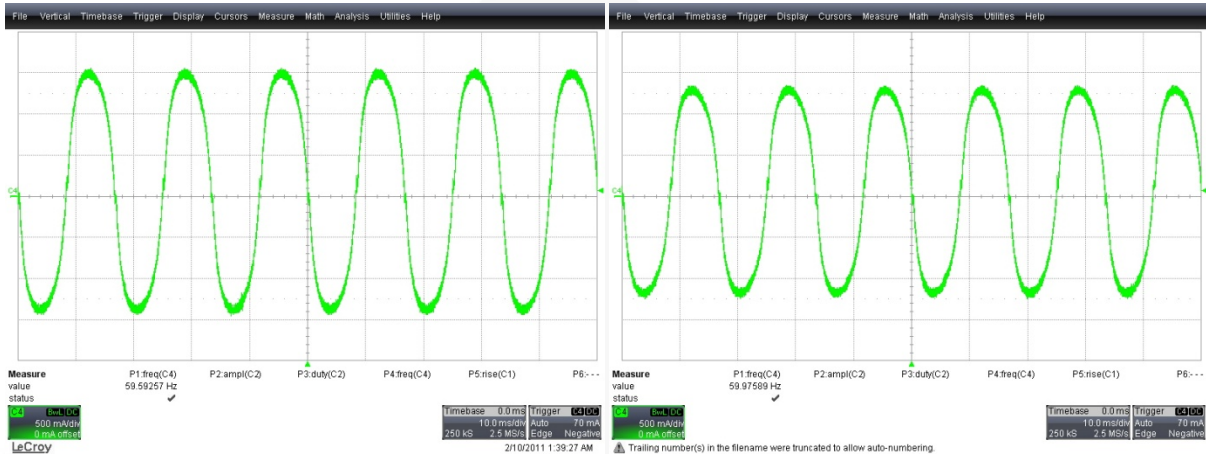


Figure 26. $V_{PFC} = 400$ V, $P_O = 100$ W; StartupTime Scale: 100 ms / div

Figure 27. $V_{PFC} = 400$ V, $P_O = 10$ W; Shutdown Time Scale: 50 ms / div

8.8. AC Input Current

Figure 28 through Figure 31 show the AC input current waveforms at the rated output power of 100 W and input voltage of 95 V_{AC}, and 265 V_{AC}; CH4: I_{AC} (500 mA / div), time scale: 10 ms / div.



8.9. Normal Operation of PFC

Figure 32 through Figure 35 show the AC input and MOSFET drain-current waveforms at the rated output power of 100 W and input voltage of 95 V_{AC}, and 265 V_{AC}; CH3: I_{D_PFC} (500 mV / div), CH4: I_{AC} (1 A / div), time scale: 5 ms / div.

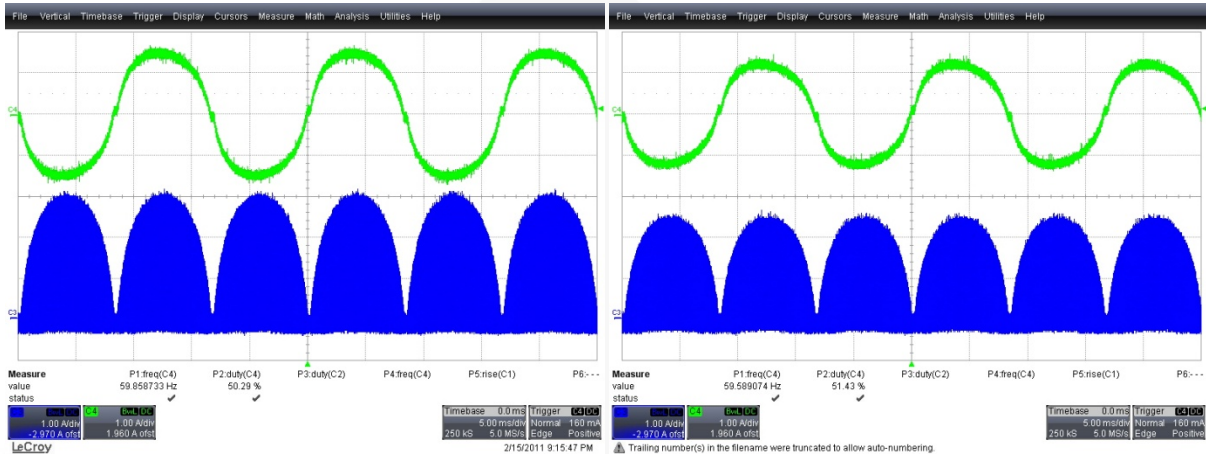


Figure 32. $V_{IN} = 95 V_{AC}$

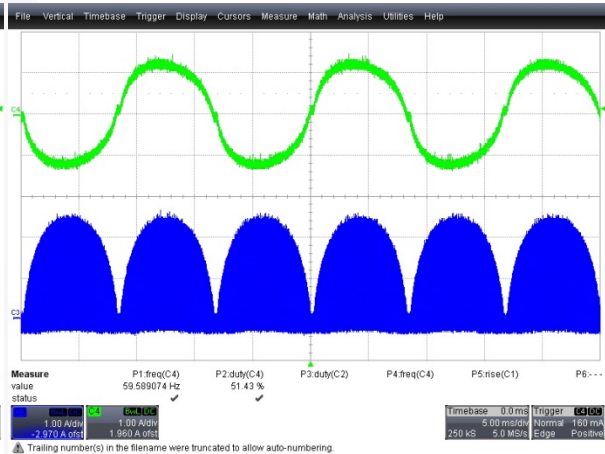


Figure 33. $V_{IN} = 115 V_{AC}$

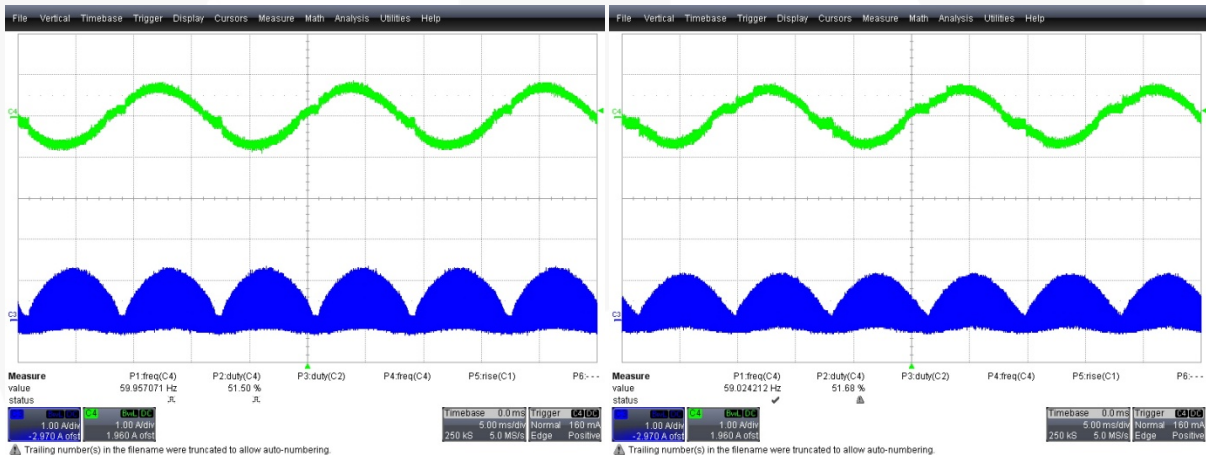


Figure 34. $V_{IN} = 235 V_{AC}$

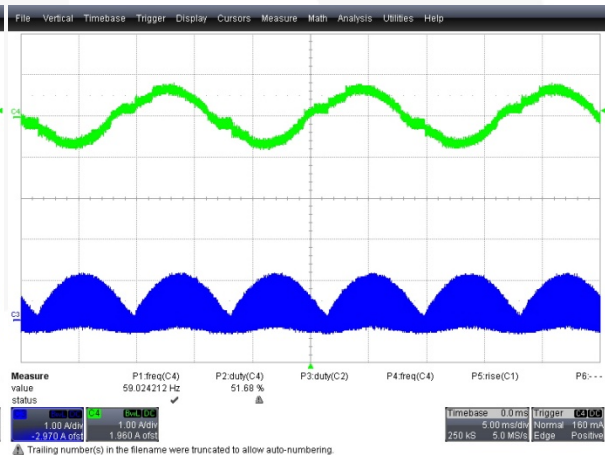


Figure 35. $V_{IN} = 265 V_{AC}$

8.10. Dynamic Performance of PFC

Figure 36 and Figure 37 show the PFC output voltage changes under about 40V when the input voltage changes from 115 V_{AC} to 235 V_{AC} and from 235 V_{AC} to 115 V_{AC} at the rated output power of 100 W; CH1: V_{PFC} (20 V / div), CH4: I_{AC} (1 A / div), time scale: 200 ms / div.

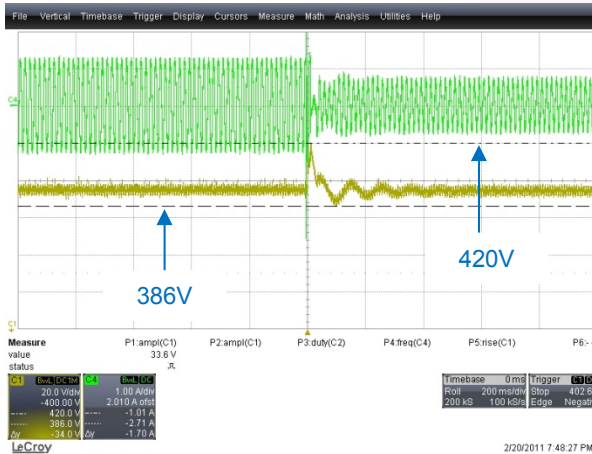


Figure 36. $V_{IN} = 115 \text{ V}_{AC} \rightarrow 235 \text{ V}_{AC}$

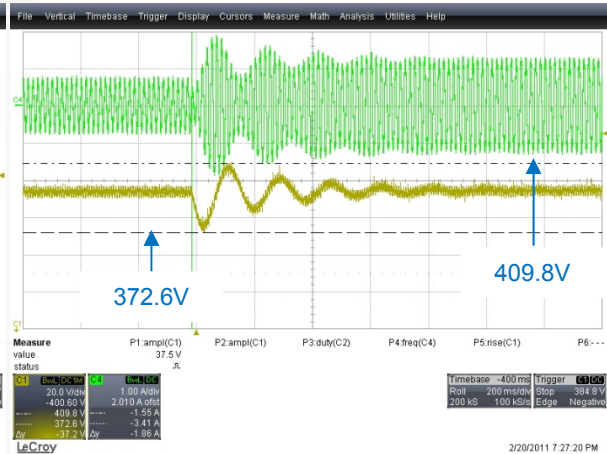


Figure 37. $V_{IN} = 235 \text{ V}_{AC} \rightarrow 115 \text{ V}_{AC}$

Figure 38 and Figure 39 show the PFC output voltage changes about 32 V when the output power changes from 14 W to 100 W and from 100 W to 14 W at input voltage of 235 V_{AC}; CH1: V_{PFC} (20 V / div), CH4: I_{AC} (1 A / div), time scale: 100 ms / div.

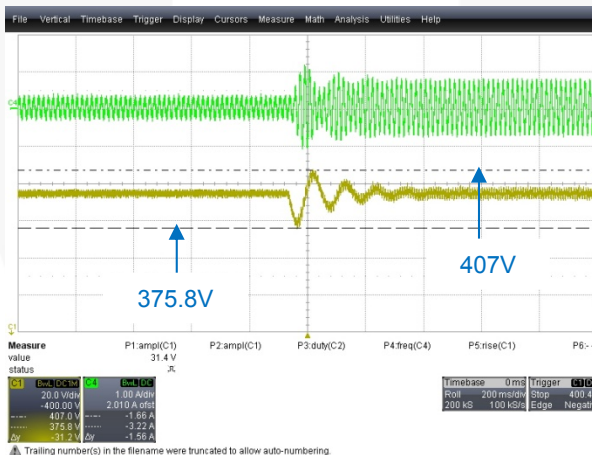


Figure 38. $P_O = 14 \text{ W} \rightarrow 100 \text{ W}$

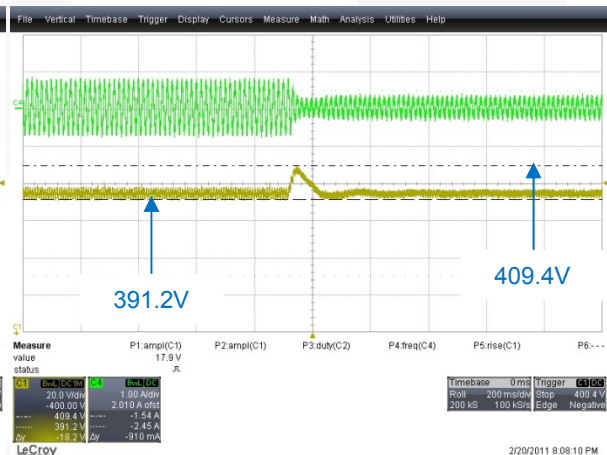


Figure 39. $P_O = 100 \text{ W} \rightarrow 14 \text{ W}$

8.11. Dynamic Performance of DC-to-DC Converter

Figure 40 shows the output voltage ripple with pulse load at nominal input voltage; CH1: V_{OUT} (5 V_{AC} / div), CH3: I_{LOAD} (1 A / div), CH4: I_{LLC} (1 A / div), time scale: 100 ms / div.

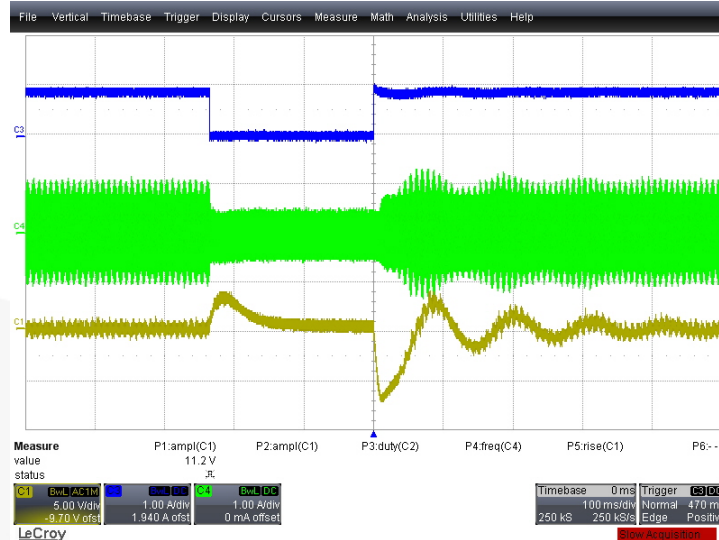


Figure 40. $V_{PFC} = 400 \text{ V}$, $I_O = 1 \text{ A} \rightarrow 0.1 \text{ A} \rightarrow 1 \text{ A}$

8.12. Dynamic Performance of CC / CV Control

Figure 41 shows the output load current and the output voltage of CC op-amp waveforms when the output load is step changed; CH1: V_{OPOUT_CC} (2 V / div), CH4: I_{LOAD} (500 mA / div), time scale: 500 ms / div.

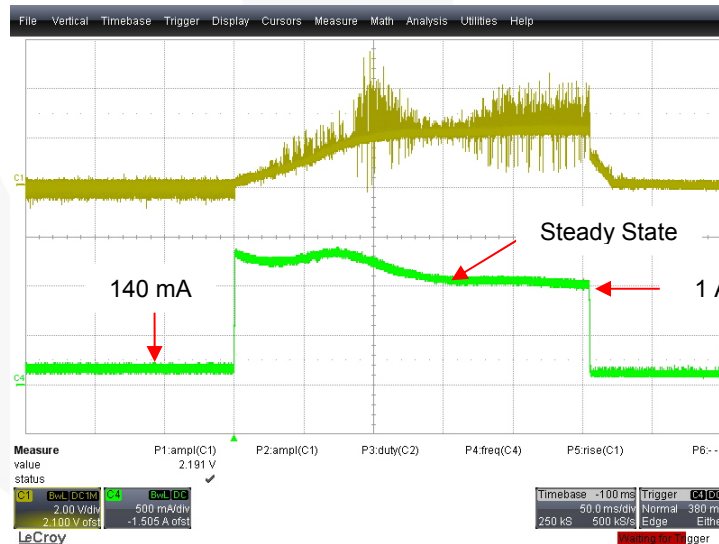


Figure 41. $V_{IN} = 235 \text{ V}_{AC}$, $I_O = 0.14 \text{ A} \rightarrow 1 \text{ A} \rightarrow 0.14 \text{ A}$

8.13. Hold-Up Time Test of DC-to-DC Converter

Figure 42 shows the hold-up time performance when the AC power source is disconnected. The output voltage is slowly decreased until FLS1800XS stops operation for about 188 ms, when the power source is disconnected; CH1: V_{OUT} (50 V / div), CH2: V_{PFC} (200 V / div), CH4: I_{LLC} (1 A / div), time scale: 100 ms / div.

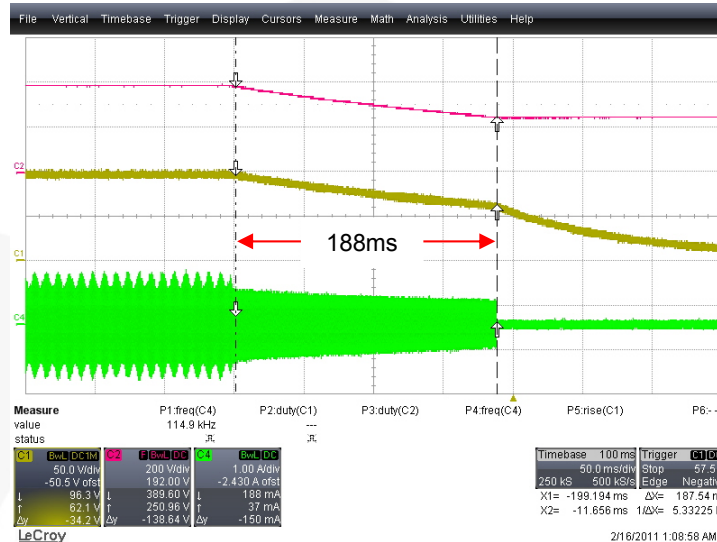


Figure 42. $V_{PFC} = 400$ V, $P_O = 100$ W

8.14. MOSFET Voltage and Current of DC-to-DC Converter

Figure 43 and Figure 44 show the resonant inductor current, low-side MOSFET current, and low-side MOSFET voltage waveforms in the primary-side at full-load and no-load; CH2: V_{DS_LOW} (200 V / div), CH3: I_{LLC} (1 A / div), CH4: I_{D_LOW} (1 A / div), time scale: 5 μ s / div.

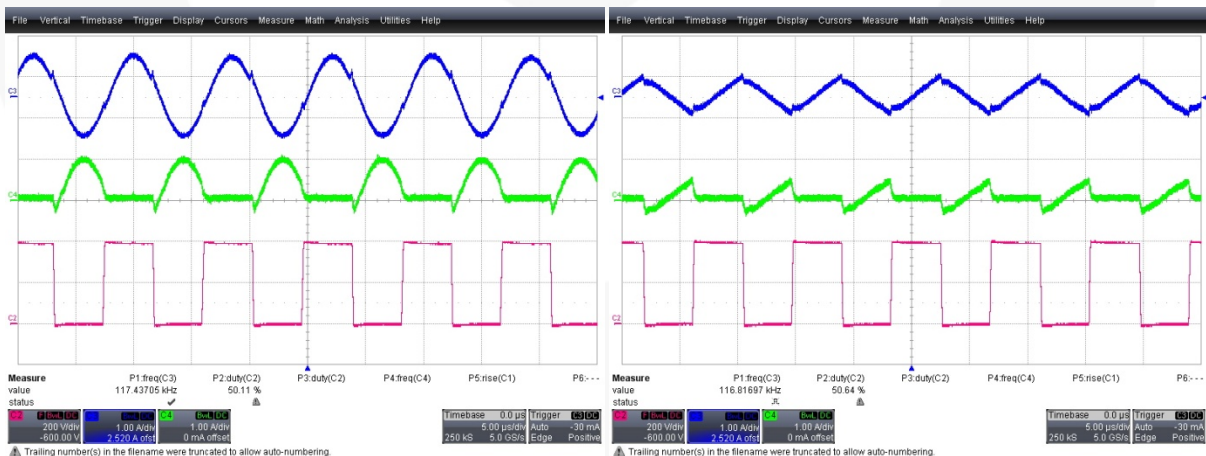


Figure 43. $V_{PFC} = 400$ V, $P_O = 100$ W

Figure 44. $V_{PFC} = 400$ V, $P_O = 0$ W

8.15. Secondary-Side Rectifier Diode Voltage and Current

Figure 45 and Figure 46 show the resonant inductor current in the primary side, rectifier diode current, and the rectifier diode voltage waveforms in the secondary side at full load. It shows the soft commutation of the rectifier diodes in the secondary side due to below resonant operation. Below resonance operation is preferred for high-output-voltage applications, such as street LED lighting systems where the reverse-recovery loss in the rectifier diode is severe; time scale: 5 μ s / div.

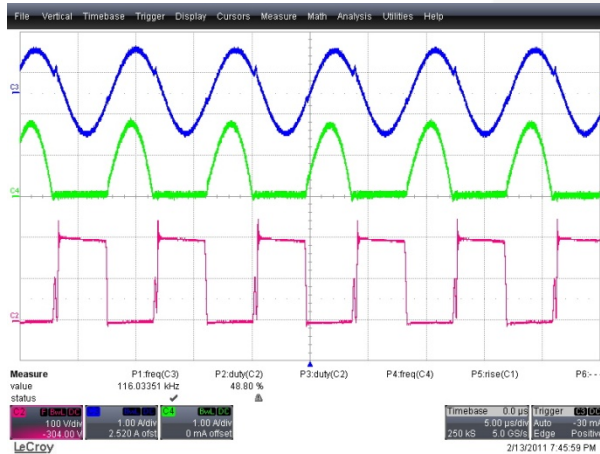


Figure 45. $V_{PFC} = 400$ V, $P_o = 100$ W; **CH2:** V_{D201} (100 V / div), **CH3:** I_{LLC} (1 A / div), **CH4:** I_{D201} (1 A / div)

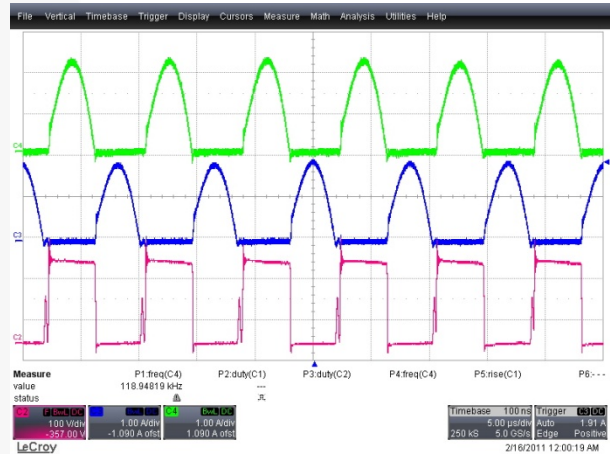


Figure 46. $V_{PFC} = 400$ V, $P_o = 100$ W; **CH2:** V_{D201} (100 V / div), **CH3:** I_{D201} (1 A / div), **CH4:** I_{D202} (1 A / div)

8.16. Operating Temperature

Figure 47 and Figure 48 show the temperature-checking results on the board in minimum and maximum input voltage conditions at the rated LED load condition.

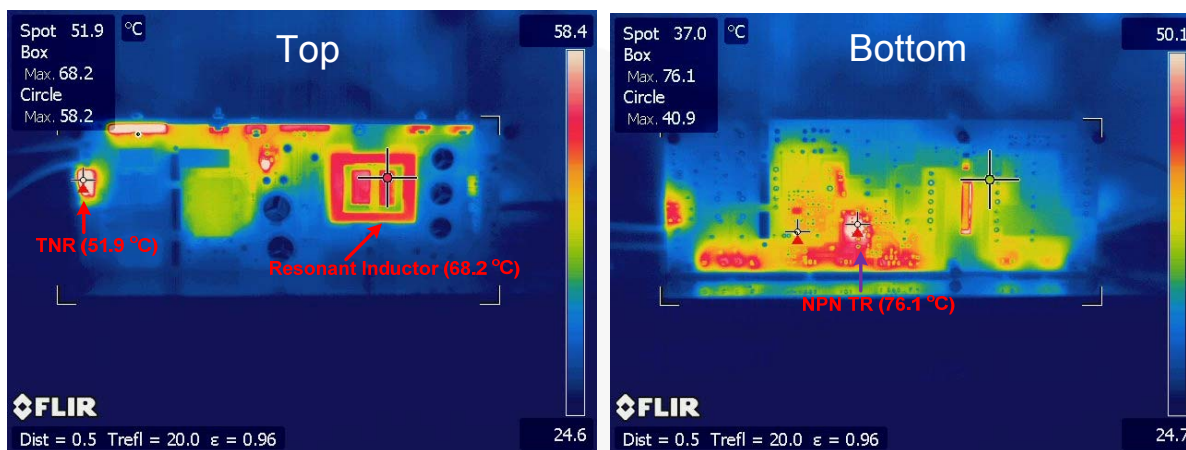


Figure 47. Board Temperature - $V_{IN} = 90 V_{AC}$

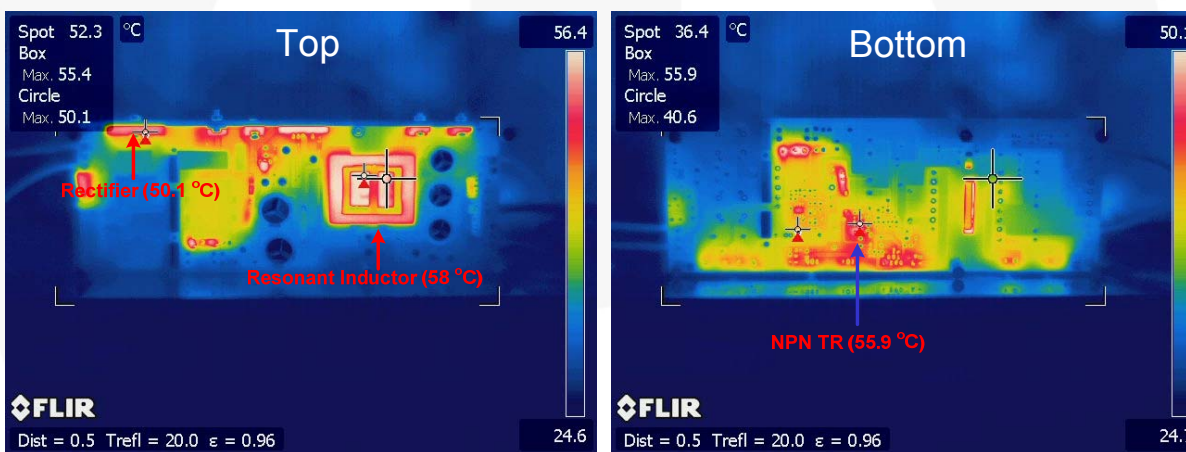


Figure 48. Board Temperature - $V_{IN} = 265 V_{AC}$

9. Revision History

Rev.	Date	Description
1.0.0	Nov. 2012	Initial Release

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Replace components on the Evaluation Board only with those parts shown on the parts list (or Bill of Materials) in the Users' Guide. Contact an authorized Fairchild representative with any questions.

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